

Maintaining Glycemic control when the pregnant woman with diabetes is hospitalized



Maribeth Inturrisi RN MS CNS CDE
Coordinator and Nurse Consultant,
Region 1 and Region 3,
California Diabetes and Pregnancy
Program@ UCSF
Diabetes Nurse Educator,
Sweet Success Program
Physician's Foundation CPMC,
San Francisco

Objectives

- Discuss the barriers to inpatient glycemic control as outlined by the AACE, ADA, AHA, AADE, JACHO 2005 Summit.
- Utilize current terminology when describing diabetes types including GDM
- Describe the 2010 recommendations for diagnosing gestational diabetes from the IADPSG-HAPO
- List the advantages and disadvantages of OGTT in pregnancy
- List the advantages of rapid-acting insulin analogs over regular human insulin
- Discuss the “harm” in using sliding scale to control BG

**Hospitalization of persons
with diabetes often leads to
inconsistency, double
messages and confusion-
all resulting in poor control-**

Summit on inpatient diabetes and glycemic control: A Call to Action

- **AACE, ADA, AHA, AADE, JACHO 2005 consensus conference examined relationship between hyperglycemia and outcomes**
 - **skepticism (AKA lack of knowledge)**
 - **resistance to change**
 - **safety issues**

ACE/ADA Consensus on Inpt glycemic control:
Diabetes care, volume 29, number 8, august
2006)

Barriers to glycemic control in the hospital

- Lack of knowledge among providers re **types of diabetes and current terminology**
- Lack of knowledge of the effects of **hyperglycemia**
- **Lack of consistency** among physicians as to how to manage
- Fear of insulin use, **fear of hypoglycemia**
- Use of **sliding scales**

(ACE/ADA Consensus on Inpt glycemic control:
Diabetes care, volume 29, number 8,
august 2006)

Barriers continued....

- Lack of coordination between feeding and administration of medications, leading to **mistiming of insulin action**
- Insufficient frequency of blood glucose monitoring
- Orders not clearly or uniformly written
- Failure to recognize the need for changes in insulin requirements because of advanced gestational age, infection, use of corticosteroids, PTL Rx with betamimetics or **TYPE OF DIABETES**

Under and over-treatment of both are SAFETY issues

- Under-treatment:
 - Fear of hypoglycemia is the greatest barrier to adequate care
 - Failure to treat significant hyperglycemia is an error of omission as hyperglycemia creates an unsafe environment for the fetus (and mom)
- Over-treatment:
 - Iatrogenic hypoglycemia- a significant safety issue - can be avoided

Lack of knowledge: Types of diabetes

“IDDM (type 2) with poorly controlled GDM”

Preexisting Diabetes

What's New and What's Not

Type 1 (5%) No longer IDDM Onset at any age	Type 2 (95%) No Longer NIDDM Onset at any age
Genetic autoimmune	Genetic or environmental Often assoc. with obesity
Absolute insulin deficiency	Insulin resistance with reduced insulin secretion
Must have exogenous insulin to survive and avoid DKA	May achieve normoglycemia with diet, exercise, Wt loss, OGLA, but almost half will require insulin

2010: Criteria for diagnosis of diabetes

1. **A1C 6.5%.** The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*

OR

2. **FPG 126 mg/dl.** Fasting is defined as no caloric intake for at least 8 h.*

OR

3. **2-h plasma glucose 200 mg/dl** during an OGTT. The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*

OR

4. In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, **a random plasma glucose 200 mg/dl.**

*In the absence of unequivocal hyperglycemia, criteria 1–3 should be confirmed by repeat testing.

Prediabetes 2010

Glucose Categories of increased risk for Diabetes

IFG: FPG 100 mg/dl to 125 mg/dl

IGT: 2-h PG in the 75-g OGTT 140 mg/dl to 199 mg/dl

A1C 5.7–6.4%

*For all three tests, risk is continuous, extending below the lower limit of the range and becoming disproportionately greater at higher ends of the range

Gestational Diabetes (GDM)

**CHO INTOLERANCE OF VARIABLE SEVERITY WITH
FIRST RECOGNITION DURING PREGNANCY**

- Incidence 7-14% (*ADA 2010*)
- **GDMA1** can achieve glycemic control with diet and exercise
- **GDMA2** need the addition of medication- insulin or OGLA.
- All have a lifetime risk of developing type2 DM (*Ratner, 2007*)



IADPSG Recommendations for International criteria for diagnosing GDM: March 2010 (HAPO Study)

All women not known to have prior diabetes undergo a 75-g OGTT at 24 –28 weeks of gestation.

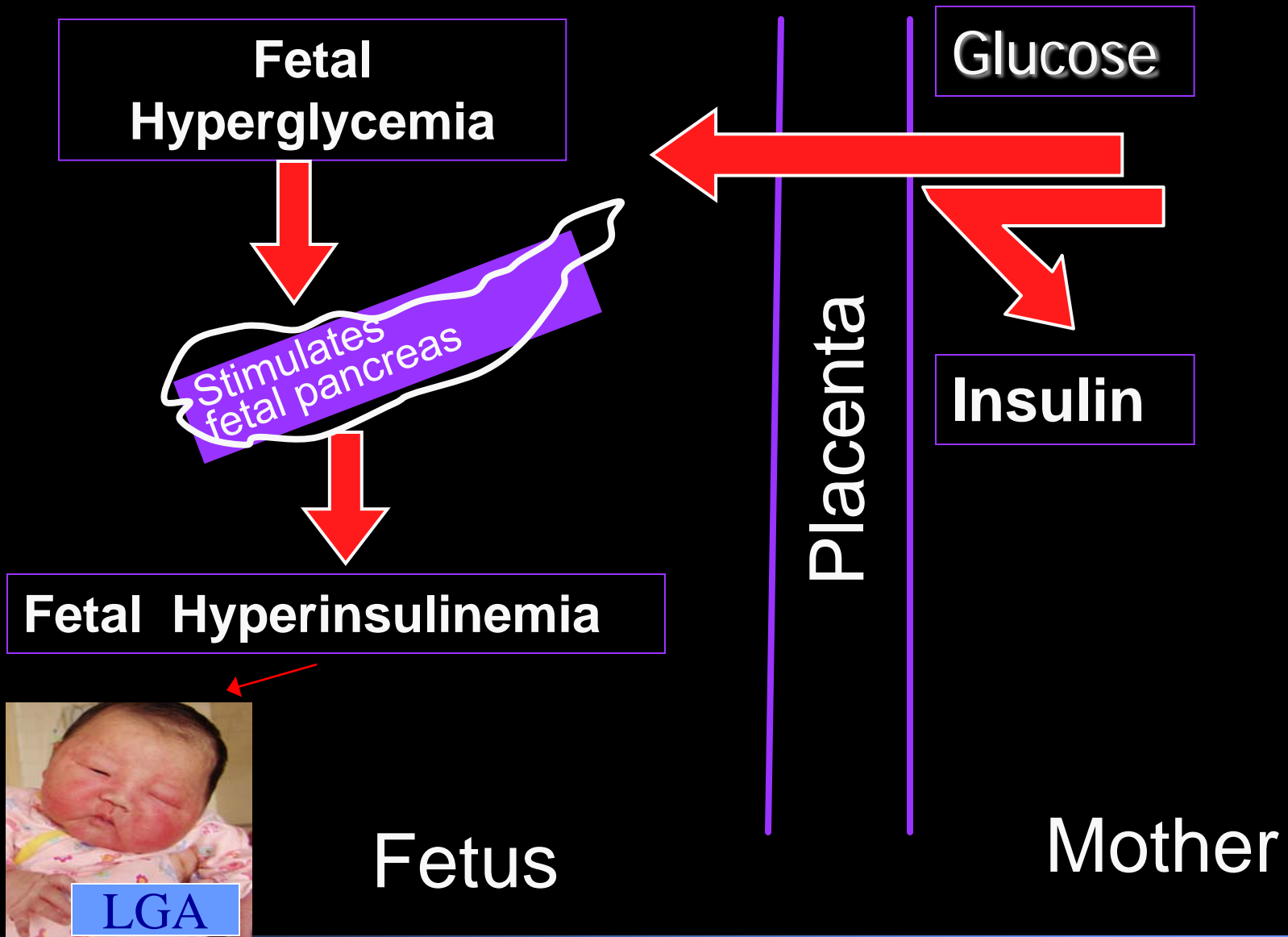
Diagnostic cut points for the fasting (92mg/dL), 1-h (180mg/dL) , and 2-h (153 mg/dL) plasma glucose measurements were chosen because They conveyed an odds ratio for adverse outcomes of 1.75.

One abnormal= GDM

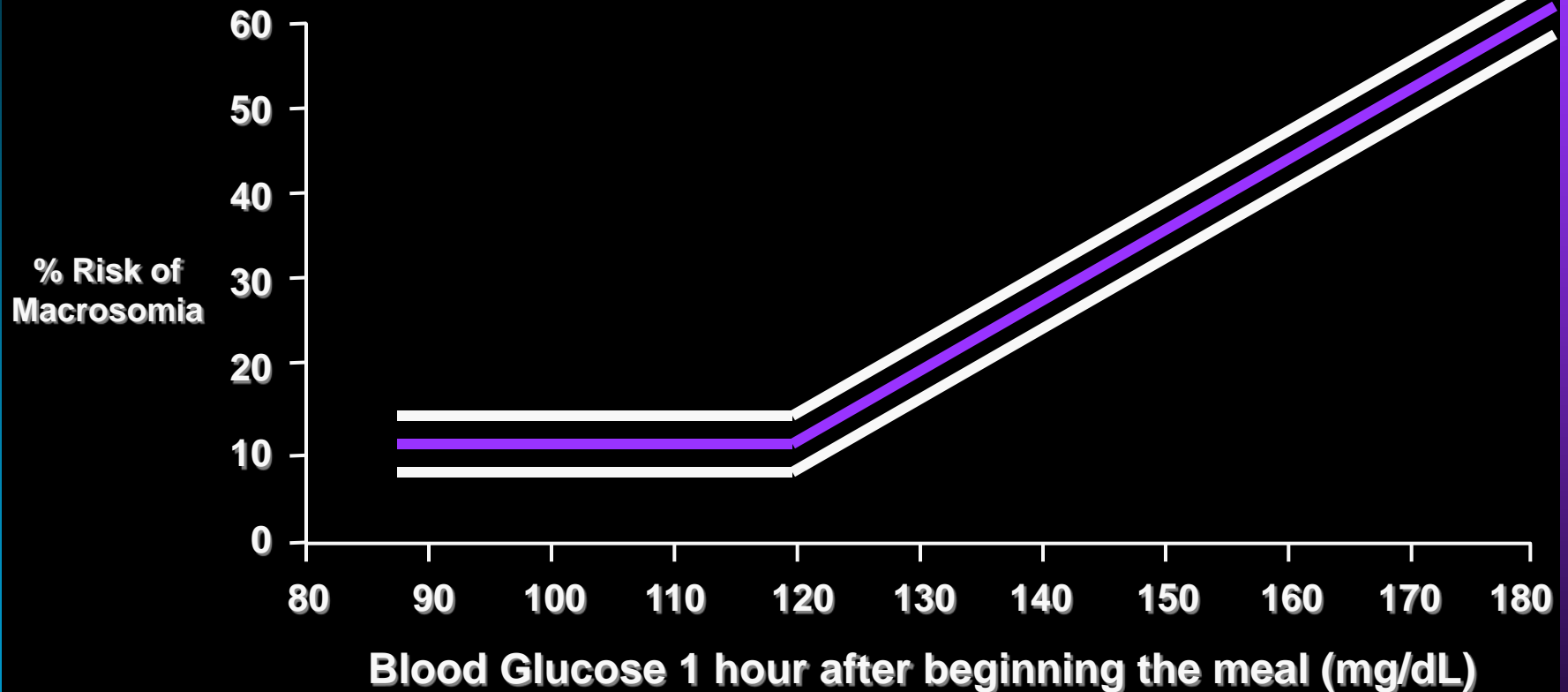
Why tight control matters

- **Hyperglycemia during pregnancy is associated with:**
 - Malformations, SAB's,
 - Macrosomia, fetal demise, birth injuries, cesarean delivery, neonatal hypoglycemia, prolonged hospital stay....
 - Worsening of maternal eye and renal damage,
 - Chronic metabolic and cardiovascular disease for mother and offspring (Silverman, DM Care 1998; Hillier, DM Care 2007; HAPO, NEJM 2008)
- **Tight glycemic control improves outcomes**
(Kitzmiller, JAMA 1991; Crowther, NEJM 2005; Landon, NEJM 2009)
- **Insulin is the most effective agent for achieving glycemic control.**

Pedersen Hypothesis



Hyperglycemic Peaks & Risk of Macrosomia



Jovanovic L et al. Maternal postprandial blood glucose levels and infant birth weight: The Diabetes in Early Pregnancy Study. Am J Obstet Gynecol. 1991;164:103.

Blood Glucose Targets for Tight Control

	Sweet Success 2009	ACOG
Fasting\ Premeal	65-90 mg/dL*	< 95
One hr Postmeal	<130 mg/dL*	< 130-140 mg/dL
Two hours postmeal	Not recommended	< 120

How to achieve tight control

Healthy eating

- RD Consult
- Order **carb controlled** diet
 - NOT ADA diet!!!- doesn't exist
 - Generally 3 meals/3 snacks:
 - » **BF:30g carb**
 - » **SN:(15-30g)**
 - » **L: 45g**
 - » **SN: (15-30g)**
 - » **D:45g**
 - » **SN:(15-30g)**



How to achieve tight control

- Stay active
 - Order ambulation x **10m. after each meal**
- **CHECK** the blood glucose
 - Minimum: 4x/day: FBG, 1 hr from first bite of BF,L,D
 - For type1&2 and some A2 may need premeal and bedtime, 3 AM
- When needed... **Take insulin.....**

Medication: when to start



- Most likely to need meds if
 - FBS on 3 hour OGTT is ≥ 95 mg/dl
 - GDM Diagnosis prior to 20 wks.



- >20% elevated glucose values after diet and/or exercise failed.



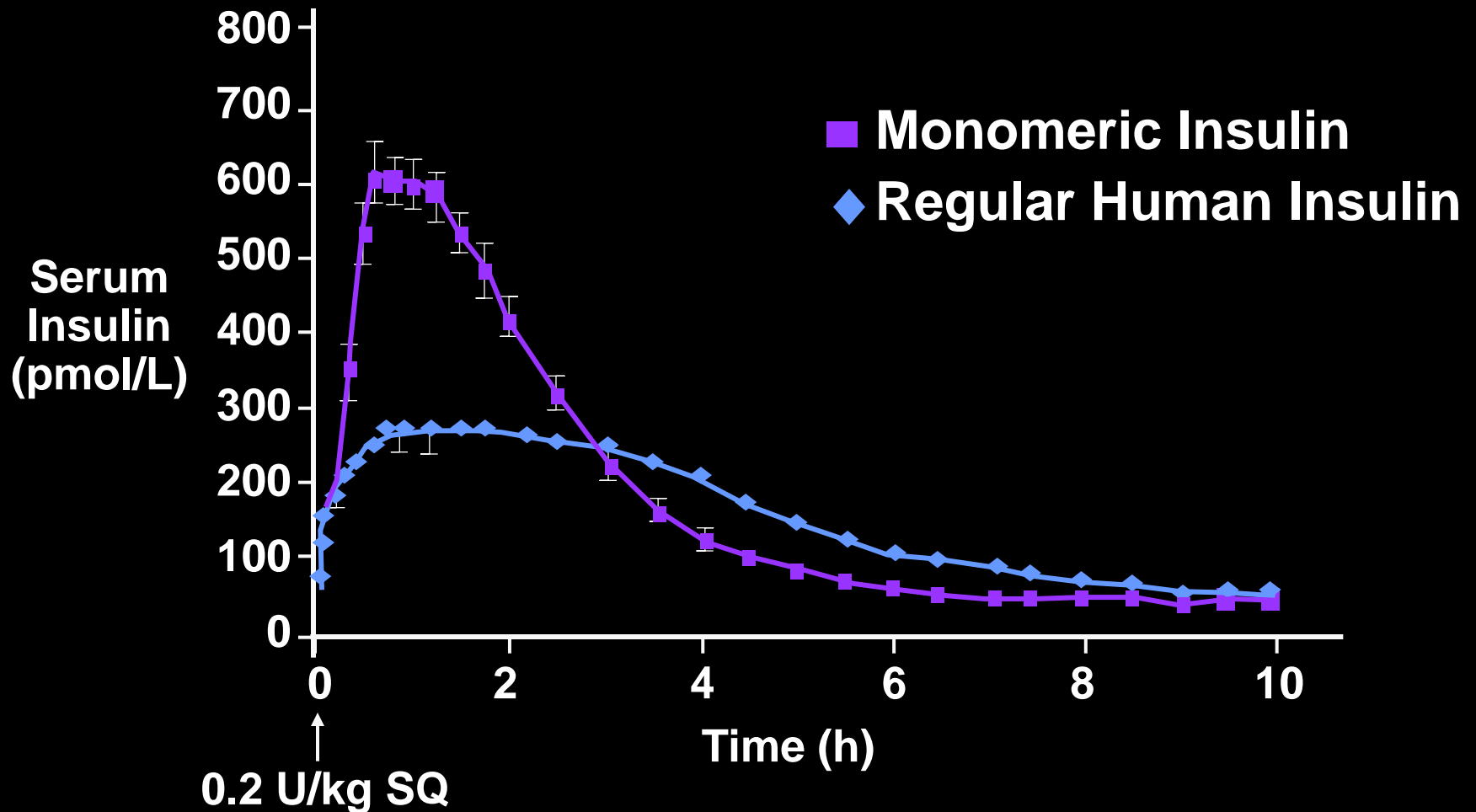
Do **OGLA** have a use in Pregnancy?

Glyburide	Metformin
Does not cross placenta?	Does cross placenta
Secretagogue- forces pancreas to secrete insulin	Increases muscle and liver cell sensitivity to insulin
Hypoglycemia	No hypoglycemia
Associated with wt gain	Associated with wt loss
60 minutes before meal to meet the peak of food	Given with meal
16% failure rate- need to d/c and add insulin	37% failure rate- need to add insulin- reduces dose of insulin needed

Insulins most used in pregnancy

	Examples	Onset	Peak	Duration
Bolus/ mealtime insulin	Lispro/ humalog Aspart/novolog Apidra/glulisine	5- 15min	30- 90 min	3-5hrs.
	Regular	30- 45min	2-4hrs.	6-8hrs.
Basal	NPH	3- 4hrs.	6-8hrs.	8-12hrs Sometimes More!

Rapid-Acting Insulin Analogues



Maternal Hyperglycemia - 1-Hour PP Glucose Concentration

Blood Glucose ≥ 120 mg/dL



* Statistically significant difference $P < 0.001$

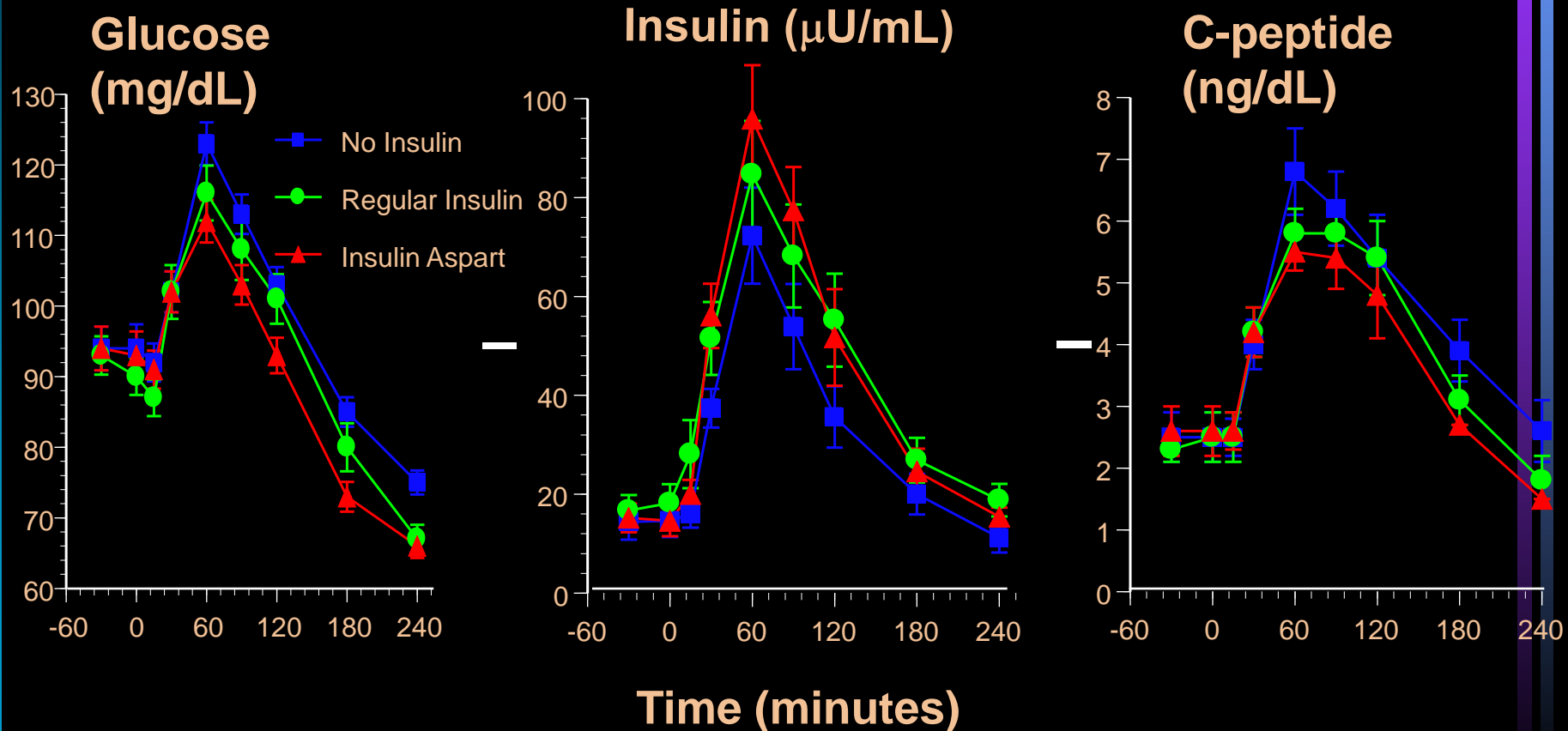
Insulin Aspart (Novolog) Study Results from 332 Births

	Aspart (Novolog)	Human Regular Insulin
Malformations 15 total	6	9
SAB total 24	11	13
Mean postprandial glucose concentrations significantly lower in the Aspart group versus Regular group after randomization and remained significantly lower for the duration of the Trial		

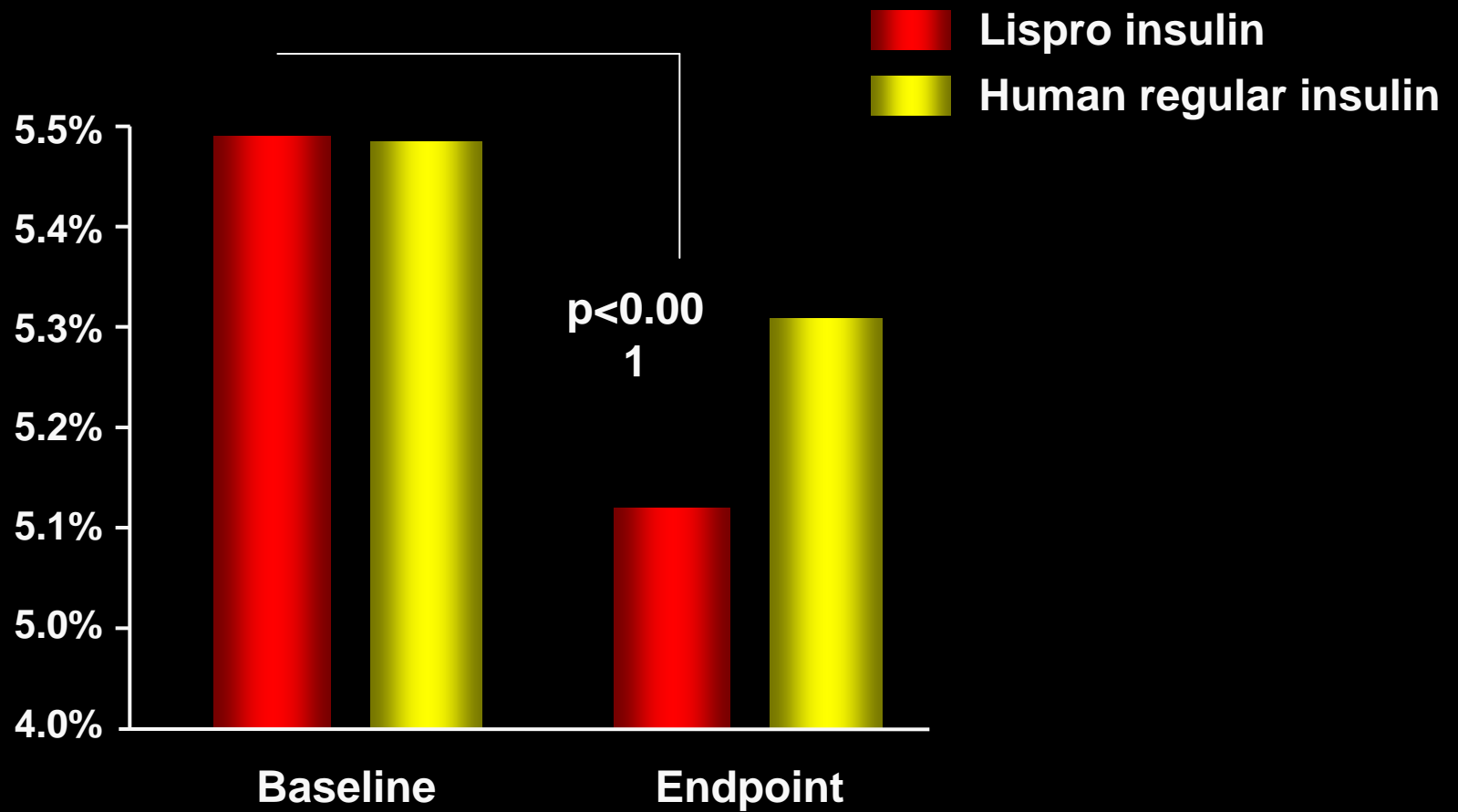
Hod et al. ADA 2006; Mathiesen E et al. ADA 2006

Postprandial Glycemic Control in GDM Aspart versus Human Regular Insulin

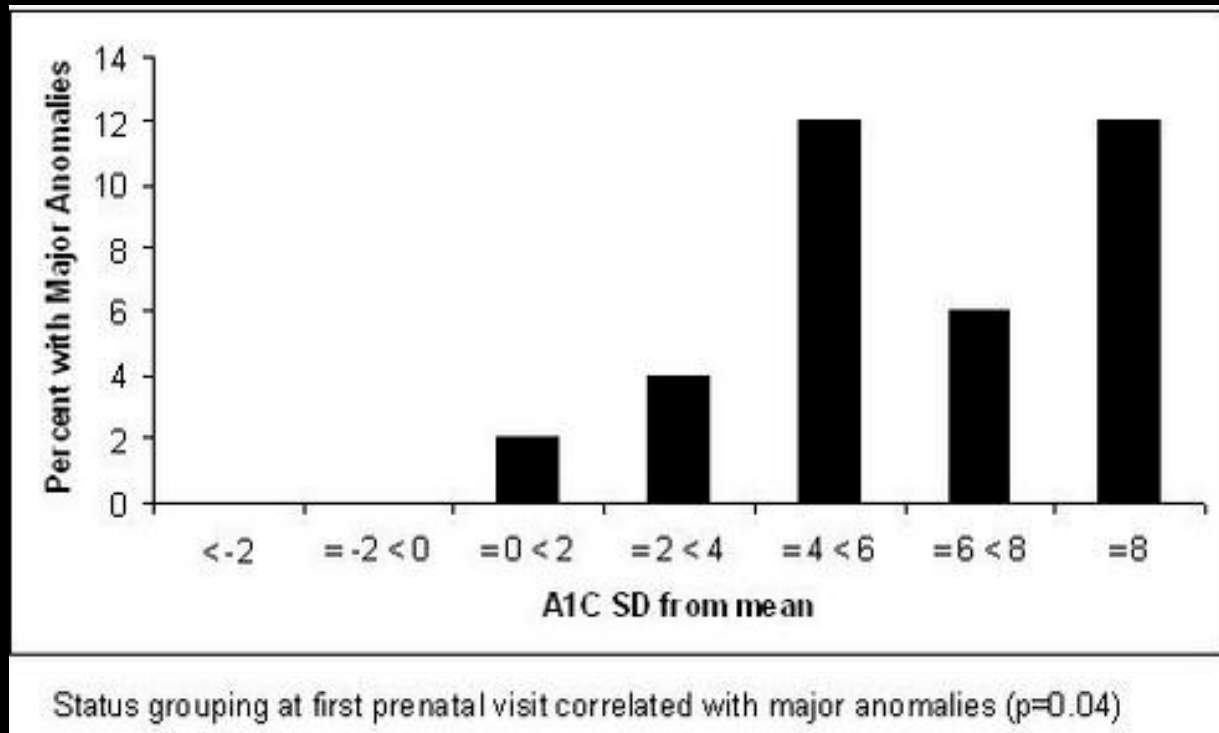
Pettitt DJ et al *Diabetes Care* 26 2003.



Change in A1C



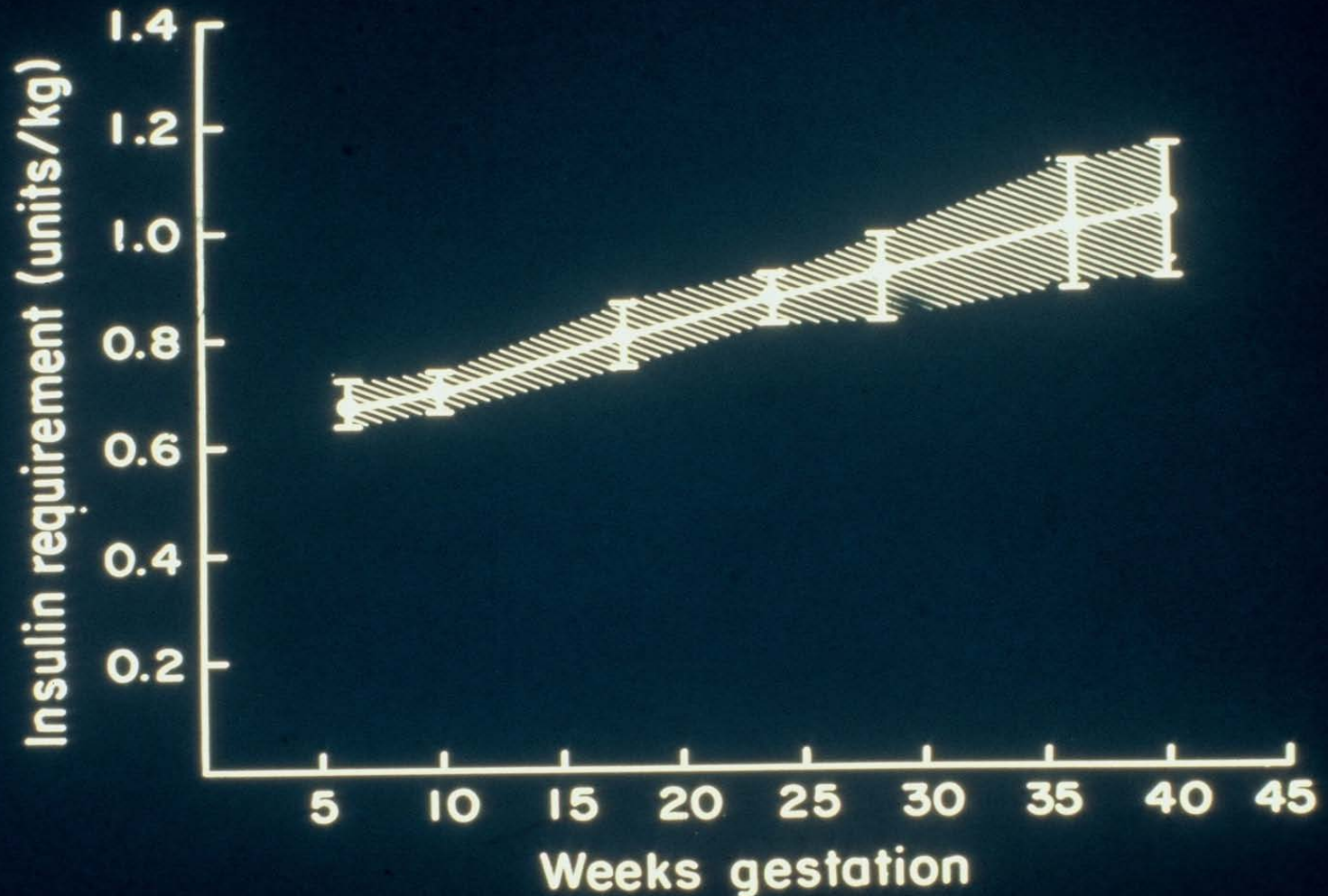
Malformations Are Related to Glucose Not Type of Insulin or glyburide or Metformin



Wyatt JW, Frias JL, Hoyme HE, Jovanovic L, et al. Congenital anomaly rate in offspring of pre-gestational diabetic women treated with insulin lispro (humalog) during pregnancy. Diabetic Medicine 21:2001-2007, 2004.

Insulins	Advantages	Disadvantages
Regular	Less expensive	<ul style="list-style-type: none"> • Peak action does not meet peak of carb after a meal • higher 1 hour BG • More hypoglycemia at 2-3h • inconvenient
Rapid acting analogs Aspart Apidra Lispro	<ul style="list-style-type: none"> • Action meets carb peak • better control of 1hr. • Less hypoglycemia • Better compliance • more convenience 	expensive
NPH	<ul style="list-style-type: none"> • Peak action near "dawn" • established safety 	<ul style="list-style-type: none"> • Variable action • "lows" during day
Long acting analogs Lantus Detemir	<ul style="list-style-type: none"> • Convenient • Longer duration of action 	<ul style="list-style-type: none"> • Peak less ? Dawn • Efficacy & safety?

Insulin Requirements for Pregnant Diabetic Women



Jovanovic L et al. Am J Med. 1980

Total Daily Dose (TDD) calculation table by weight and gestational age

Weeks of Gestation	Type1	Type 2 or GDM A2
1-18	0.5-0.7 units/kg	0.7-0.9 units/kg
18-28	0.6- 0.8 units/kg	0.8-1.0 units/kg
28-36	0.8-0.9 units/kg	0.9 -1.1 units/kg
36-40	1.0 units/kg	1.0-2.0 units/kg

Modified from Sweet Success Pocket guide to account for under and overwt.

Total daily Insulin doses (basal plus bolus) depend on

- type of diabetes,
- current weight,
- blood glucose control,
- gestational age
- individual response.



“Maria” type 2, 4' 8" 60kg, 10 wks GA, TDD = 42

Basal and Bolus Insulin

The total daily dose (TDD) of insulin should be divided into

Basal (background insulin- that which the pancreas secretes slowly through out the day to keep blood glucose levels controlled when the liver is the only source of carbs

Bolus (Insulin needed to keep blood glucose levels controlled when carbs are ingested).

- **carb bolus** – amt of insulin needed to cover carbs in a meal
- **correction bolus** – amt of insulin needed to lower high readings to a target level- usually 100mg/dl prior to a meal

Example of Basal/Bolus Insulin Dosing "Quick Start" (60Kg@10weeks) Type 1 and 2

Premeal **bolus** calc:

$0.25 \times 60\text{kg} = 15 \text{ units}$

rapid-acting analog-total dose

Bedtime **Basal** Calc:

$0.2 \times 60 = 12 \text{ units NPH}$

May not need daytime basal

Give larger dose at breakfast: 7 units

Give equal doses before lunch and dinner: 4 units each

If needed add small doses **NPH** before breakfast and lunch. Calc dose: $60 \times 0.7 = 42 \text{ units TDD}$, divided by 50% = **21 units total basal dose** minus the bedtime dose (12) = 9 units. Give 5 @ Bf and 4 @ lunch

Example of Insulin dosing for mild hyperglycemia- GDM A2

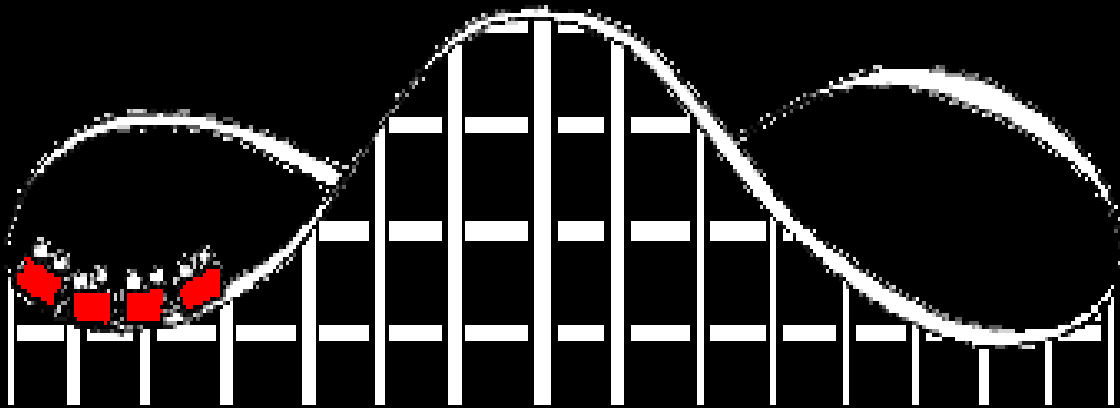
Glucose value	Insulin Dose
Fasting >90 <120	0.2 X Kg current wt NPH
1 hr post breakfast >130 <180	2-4 units rapid acting analog
1 hr post lunch >130 <180	2-4 units rapid acting analog •May use BF NPH to avoid lunchtime injection: 4-6 units
1 hr post dinner >130 <180	2-4 units rapid acting analog

- Use basal/bolus regimen
 - Rapid acting analogs before meals (bolus) and bedtime NPH (basal)
 - Increase dose as needed every 2-3 days
- Use enough insulin to achieve targets!
- Abdominal SC sites for optimum absorption
- Optional
 - Insulin to Carb ratios
 - premeal correction algorithms
- NO SLIDING SCALES !!!



Insulin Algorithms-NOT sliding scales-know the difference!!

- Algorithms prevent hyperglycemia while sliding scales chase hyperglycemia, often stacking insulin and causing iatrogenic hypoglycemia which then is over treated causing hyperglycemia and the ride continues.....



Recommendations from ACE, ADA, and JCAHO.....

- The traditional regular insulin “sliding scale” should be abandoned as the standard of care.
- This “retroactive” form of insulin replacement is inherently illogical and has been associated with increased glycemic excursions.



Premeal (breakfast/lunch/ dinner)

Algorithm based on 1:20 Correction

- < 60 mg/dl take 2 units less than basic dose
- 60 - 80 mg/dl take 1 unit less
- 81 - 100 mg/dl no change
- 101 - 130 mg/dl take 1 unit extra
- 131 - 160 mg/dl take 2 units extra
- 161 - 180 mg/dl take 3 units extra
- 181 – 200 mg/dl take 4 units extra
- If greater than 200 mg/dl, check urine for ketones and call MD

Back to our example....

- Maria's lunch is 2 corn tortilla, 1/3 C rice, chicken fajita
- ICR (insulin to carb ratio) 1:7
- Lunch is 45 carbs
- She will require a basic dose of 6 units lispro
- However, her BG just before lunch is 125mg/dL.
- Based on the premeal algorithm she needs 7 units before this meal to correct for the higher premeal glucose.

Maria PPROM's @ 33 weeks

- She will receive BMZ
- How will this affect her insulin dose?



Dosing Insulin during Betamethasone (BMZ) Rx

- BMZ 12 mg. IM q12h- 24 hours (two doses).
- Day One Double all insulin doses
- Day Two: Continue with increased dose; modify as needed for BG ().
- Day Three: Decrease the previous day's increase by 50%. and add to original dose.
- Day Four: Adjust to pre-BMZ insulin dose and regimen
- Check pre and postmeal BG, Fasting, bedtime, 3AM while on BMZ

Targets Fasting/Premeal: <100 One Hour Post Meal: <135 Bedtime: ~90 3AM

Time	MN	1	2	3	430	5	630	7	730	8	9	10	11	12	130	2	3	4	530	6	7	8	9	10	11	
BG	70			135	125				137	152	185	191	212	185	145	198	216	165		180	170	164	210	197		
Carb g	12g									45g									19g	60g						
Insulin bolus										10u																
Basal rate																										
Correction 1:55					0.6				1.9			0.95u	1.5u			3.1u	3u	6u		7.1		1	4	4.4		
Activity																										

Time	Breakfast	CHO
915	Oatmeal/eggs	15g
915	english muffin	30g
Time	Snack I/C _____	CHO

Time	Lunch	CHO
1230	Salad/mushroom ravioli	45g
530	yogurt	17g
Time	Snack I/C _____	CHO
530	Apple/cheese	19g

Time	Dinner	CHO
630	chicken sandwich	60g
	soup	
Time	Snack	CHO

Intravenous Insulin Algorithm for Labor

• CBG	T1	T2	GDMA2
• <70	0	0	0
• 71-90	0.5	0	0
• 91-110	1	1	0
• 111-130	2	2	2
• 131-150	3	3	3
• 151-170	4	4	4
• 171-190	5	5	5

IV Insulin in OB cont....Intravenous fluids

- **Main line** (usually LR or NS).
 - non glucose containing,
 - non medication containing,
 - infusing at least TKO at all times
- **Insulin**
 - piggyback close to the IV hub of this mainline via an infusion device
- **Glucose (D51/2 NS)**
 - Most women will need a basal glucose infusion of 5 to 7g Dextrose per hour: e.g., at 100–125 mL/hour (if NPO)
 - via an infusion devise.

Postpartum Management



- Cut insulin algorithm in half. (DM1&2) or
- D/C IV insulin after placenta (GDMA2) (or DM2)
- Aim of therapy is to keep BG in the following target:
FBG < 100; one hour post-meal <150 – 160 (DM 1&2)
; <140 GDM

Breastfeeding reduces risks for mom and babe related to obesity, CVD, and DM



- Reduces insulin requirements- **check BG before and after feeding** a few times
- Type 1 may be prone to hypoglycemia especially at night- may need to dial down NPH further.
- Organize snacks (15 gm) around infant feedings

Key Factors to successful insulin management in the hospital

- Standardized protocols, developed by multidisciplinary teams, are necessary to ensure safety and efficacy. Everyone on the same page!!!! Everyone trained!!!
- Glucose levels must be monitored frequently !!!!
- Two way communication – especially about changes in patient status

NO WAY!!!!

